Model Preparation:Data Collection & Analysis

Battery Physics Data

Smartphone Power Profile

OCV Curve Fitting

Load Profile Generation

Assumptions

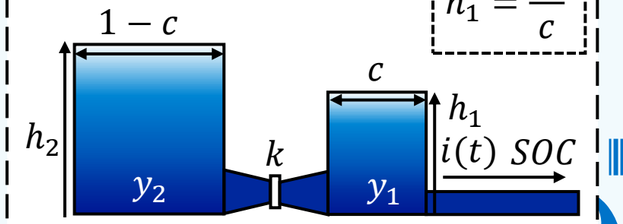
Thermal Hypothesis

Kinetic Hypothesis

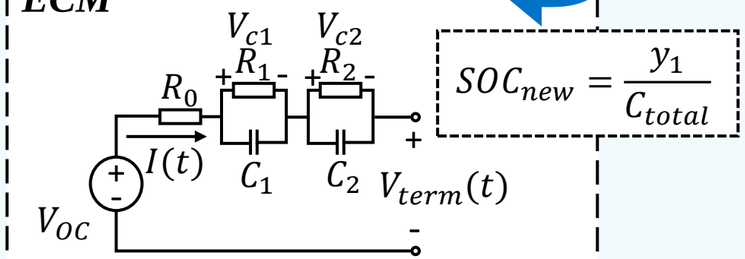
Aging Hypothesis

Model I:Hybrid Kinetic-Equivalent Model

KiBaM



ECM



$$SOC_{new} = \frac{y_1}{C_{total}}$$

System of ODE

$$\frac{dy_1}{dt} = -I(t) + k\left(\frac{y_2}{1-c} - \frac{y_1}{c}\right)$$

$$\frac{dy_2}{dt} = -k\left(\frac{y_2}{1-c} - \frac{y_1}{c}\right)$$

$$\frac{dV_{ci}}{dt} = \frac{I(t)}{C_i} - \frac{V_{ci}}{R_i C_i}$$

Terminal Voltage & Runtime Estimation

$$V_{term} = V_{OC} - V_c - IR_0$$

$$V_{term}(t_{off}) = V_{off}$$

$V_{OCV}(SOC_{new})$

Logic Flow

$I(t)$ → User Behavior → Realtime SOC → $SOC_{new}(t)$ → Non-linear Mapping

$R_0(SOC), R_i(SOC), C_i(SOC)$

Improved Model I

Model II:SOC Estimation Based on FFRLS-UKF

Algorithm A: Parameter Identification (FFRLS)

Discretize Differential Equations → Construct Regression Vector → Calculate Model Parameters → Initialize Parameters

Algorithm B: State Estimation (UKF)

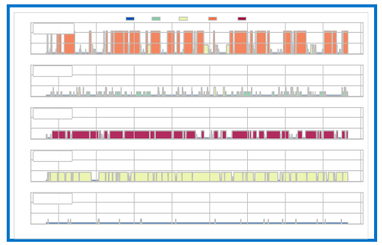
Initialize State → Generate Sigma Points → Output SOC(k) → Predict Measurement

Model Application & Problem Solving

Analysis of Different Scenarios

Power Consumption: Screen, WIFI, GPS, CPU

Current Distribution

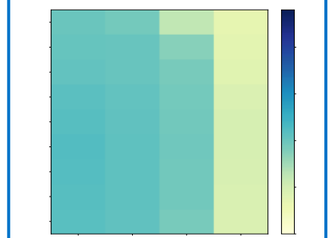


Battery Aging Analysis: High Temperature, Low Temperature

Runtime Estimation

Different Personas

Initial Capacity



Sensitive Analysis

Changing Parameters → Robustness & Stability